Missouri Department of Natural Resources

Total Maximum Daily Load Information Sheet

Eaton Branch

Water Body Segment at a Glance:

County: St. Francois
Nearby Towns: Leadwood
Length of impaired segment: 3 miles
Length of impairment within segment: 0.9 mile
Pollutant: Lead (S)[1]
Cadmium (S,W)
Zinc (S,W)
Source: Mill tailings (Abandoned)
Water Body ID: 2166


State Map Showing Location of Watershed

Scheduled for TMDL development: 2010

Description of the Problem

Beneficial uses of Eaton Branch

- Livestock and Wildlife Watering
- Protection of Warm Water Aquatic Life
- Protection of Human Health (Fish Consumption)
- Whole Body Contact Recreation

Uses that are impaired

- Protection of Warm Water Aquatic Life
- General Criteria

Standards that apply

- Missouri Water Quality Standards found in 10 CSR 20-7.031(4)(B)1 state:

> Water contaminants shall not cause the criteria in Tables A and B to be exceeded. Concentrations of these substances in bottom sediments or waters shall not harm benthic organisms and shall not accumulate through the food chain in harmful concentrations, nor shall state and federal maximum fish tissue levels for fish consumption be exceeded.

[1] (S) = in sediment/soil; (W) = in water as dissolved metal

- Table A of the Water Quality Standards contains dissolved cadmium and zinc criteria for the protection of aquatic life designated use. These criteria are hardness dependent and calculated from the formulas shown below:

  Dissolved Cadmium (DCd)

  Chronic = $e^{(0.7409 * \ln(\text{hardness}) - 4.719948)} * (1.101672 - (\ln(\text{hardness}) * 0.041838))$ = micrograms per liter, or μg/L

  Dissolved Zinc (DZn)

  Chronic = $e^{(0.8473 * \ln(\text{hardness}) + 0.785271)} * 0.986$ = μg/L

- Missouri has no standards for metals in sediment. Likewise, the U.S. Environmental Protection Agency has not yet established federal guidelines for toxic chemicals in stream or lake sediments. In lieu of such criteria, Probable Effect Levels suggested by McDonald, et. al[2], are used. PELs are the concentrations at which some toxic effect on aquatic life is likely

Background information and water quality data

Eaton Branch is a small creek that drains the Leadwood Mine Tailings Site in St. Francois County. An estimated 5,100,000 cubic yards of mine tailings remain at the site from over 65 years of lead mining[3]. When the mine was active, the Eaton Branch valley was dammed and used for storing the mining and milling waste material (called tailings). Eaton Branch is a tributary to Big River, which is also impaired for metals contamination. The impairment in Big River clearly begins where Eaton Branch enters, as tailings in the river appear and the aquatic life dramatically decreases at the confluence point. The Leadwood Mine Tailings Site impounds most of Eaton Branch, with only 0.9 mile of the creek remaining.

Seven data sets from Eaton Branch were collected from the water column in 1988-89 by the U.S. Geological Survey. These showed average dissolved zinc and cadmium levels well above department criteria. The department conducted additional monitoring in 2003-08. A water body is judged to be impaired by dissolved metals if chronic or acute numeric criteria are exceeded on more than one occasion during the last three years for which data is available. These metals criteria are dependent on the hardness of the water. Using a hardness value of 345 mg/L (the 25th percentile of all hardness data from Eaton Branch), chronic values for dissolved cadmium and zinc are calculated as 0.58 μg/L and 305.6 μg/L respectively. Therefore, six cadmium and seven zinc values exceeded the chronic criteria in the last three years (see Figures 1 and 2).

In addition to high levels of metals in the water column, contamination of stream sediments has led to the contamination of fish and other aquatic life. New studies are showing that the lead and other metals in these tailings are toxic to mussels, crayfish and other small invertebrates that inhabit the bottom of the river. It is already known that lead bioaccumulates in the bodies of aquatic creatures, which has been documented in the levels of lead in fish in Big River.

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[2] *Development and Evaluation of Consensus-Based Sediment Quality Guidelines for Freshwater Ecosystems*, D. MacDonald, et al., 2000

[3] *Focused Remedial Investigation for Mined Areas in St. Francois County, Missouri.* NewFields, March 3, 2006.

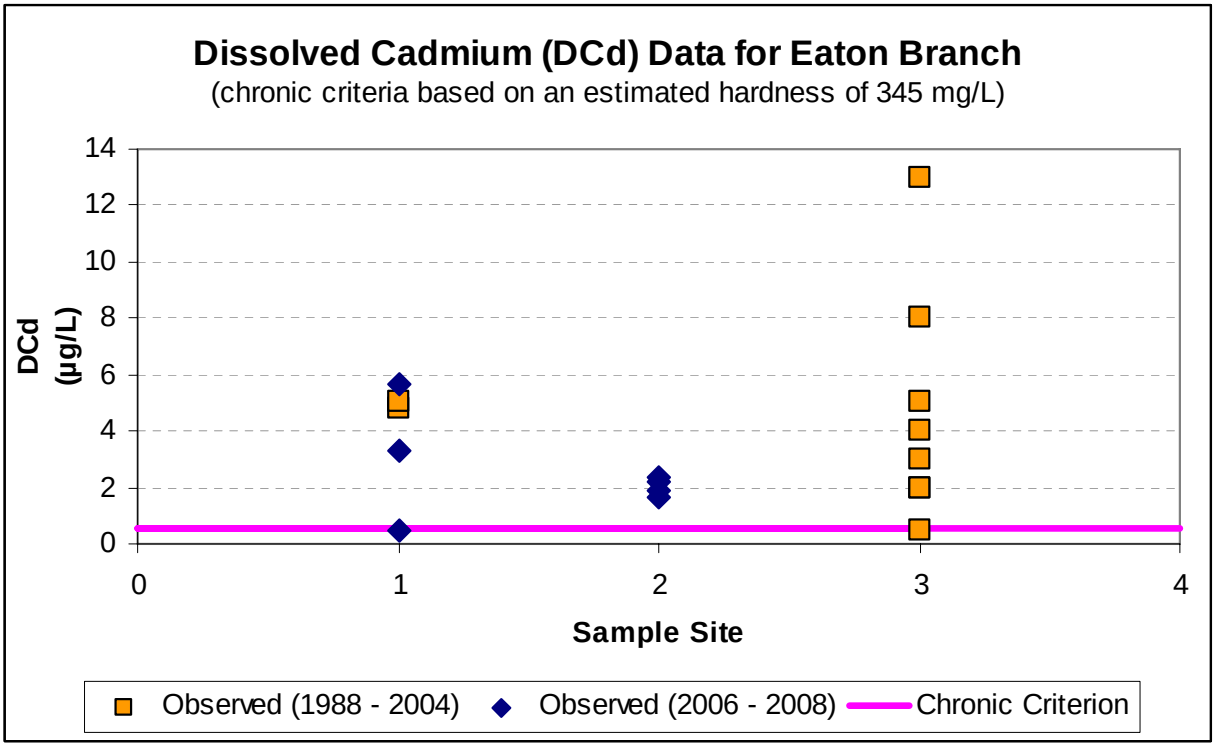


Figure 1

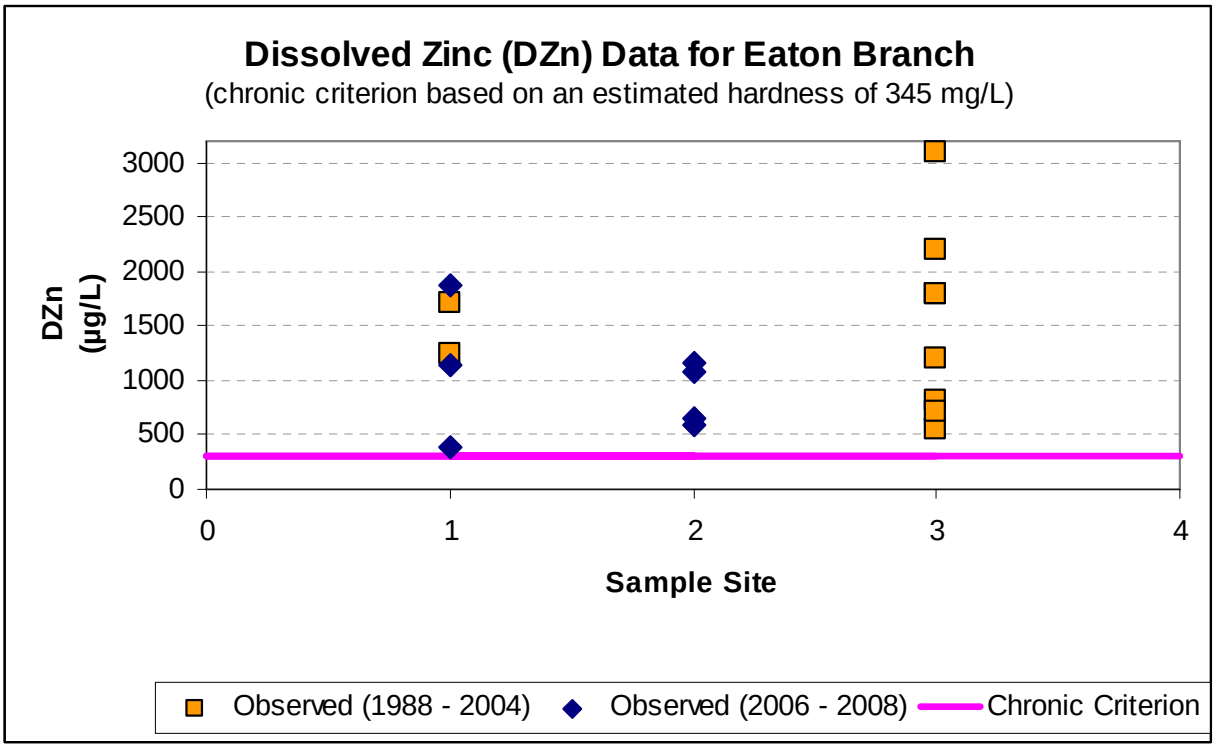


Figure 2

The department collected four sediment samples from Eaton Branch in 2003 (see table below). The mean (average) concentration of lead in the sediments is 2305 mg/kg (milligrams per kilogram, or parts per million). This is 18 times the PEL. The mean concentration of cadmium is 69.3 mg/kg, four times the PEL and the mean concentration of zinc in the sediments for Eaton Branch is 2488 mg/kg, five times the PEL.

Metals in Sediment Data (mg/Kg) for Eaton Branch

Site	Cd	Pb	Zn
1	64.7	3090	1630
1	57.7	1150	1730
1	78.9	2490	2680
1	76	2490	3910
mean:	**69.3**	**2305**	**2488**
PEL:	**4.98**	**128**	**459**

Biological assessments also show that Eaton Branch is impaired. The aquatic community was sampled by the department in the fall of 2003 and spring of 2004. Stream Condition Index scores of 16 or more are considered to reflect unimpaired biological communities (the aquatic creatures big and small that can be expected in a healthy stream system). Reference streams in Eaton Branch's Ecological Drainage Unit score 16 or higher on 84.6 percent of all samples. However, both samples in Eaton Branch scored only 12.

All of these metals can be harmful to the environment and life in all its forms. In humans, lead primarily affects the nervous system, blood cells and processes for the metabolism of Vitamin D and calcium. Lead can affect the developing fetus during pregnancy and cause lower IQ scores, poor attention levels, hearing, speech and language problems, reading disabilities, reduced motor skills and poor hand-eye coordination in young children. According to the Missouri Department of Health and Senior Services, four percent of the children less than 72 months (six years) that were tested for lead in St. Francois County in 2008 had a blood lead level at or above 10 micrograms per deciliter, or µg/dL, which is considered lead poisoning. Statewide of those tested, one percent of children less than 72 months have elevated blood lead levels.

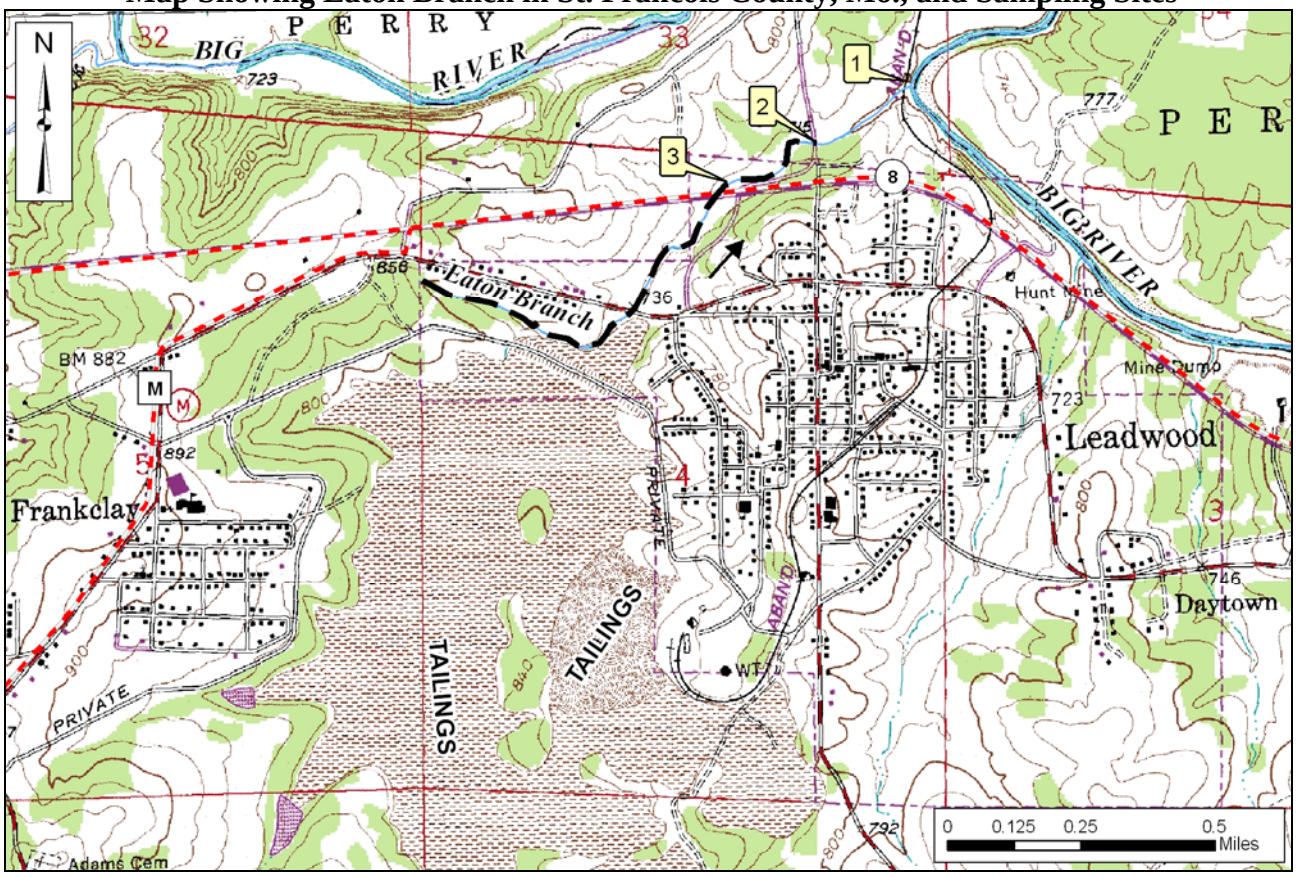
Both zinc and cadmium are minor components in most lead ores and therefore are by-products of lead production. Although zinc is an essential requirement for good health as a trace mineral, excess zinc can be highly toxic. The free zinc ion in solution is highly toxic to plants, invertebrates and even vertebrate fish[4]. It tends to bioaccumulate in the environment and can produce certain behavioral and physiological effects in test organisms exposed to high levels. In humans, it can cause stomach cramps, anemia, and changes in cholesterol levels.

With the exception of its use in nickel-cadmium batteries, the use of cadmium is generally decreasing in all other applications, such as pigments and corrosion resistant plating. This decrease is due to the high toxicity and carcinogenicity of cadmium.

[4] Eisler, Ronald (1993). "Zinc Hazard to Fish, Wildlife, and Invertebrates: A Synoptic Review" (PDF). *Contaminant Hazard Reviews* (Laurel, Maryland: U.S. Department of the Interior, Fish and Wildlife Service) (10). http://www.pwrc.usgs.gov/infobase/eisler/chr_26_zinc.pdf.

To address these problems, the Leadwood tailings pile is in the process of being stabilized. That is, the slope of the sides has been decreased to 3:1 and the sides armored with large rock to prevent further erosion. The top is being leveled and top soil added, amended with organic material and planted with vegetation. A pool has been created at the base of the pile to catch and treat storm runoff before is reaches the creek. When these measures are complete, removing contaminated sediment already in the creek will be addressed.

Map Showing Eaton Branch in St. Francois County, Mo., and Sampling Sites



Impaired Segment → Direction of flow

Sample Sites
1 – Eaton Branch at mouth
2 – Eaton Branch at Huntsford Road
3 – Eaton Branch at State Highway 8

For more information call or write:
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